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CHANGE IN LEVEL OF 5-HT CONTAINED IN PERIPHERAL BLOOD OF WORKERS EXPOSED TO MICROWAVE AND HIGH-FREQUENCY RADIATION

by

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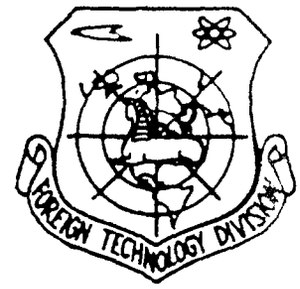

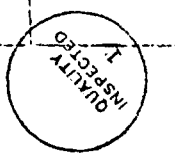

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CHANGE IN LEVEL OF 5-HT CONTAINED IN PERIPHERAL BLOOD OF WORKERS EXPOSED TO MICROWAVE AND HIGH-FREQUENCY RADIATION

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This article will acquaint the reader with the study of relationship between the level of 5-HT (5-hydroxytryptamine) contained in peripheral blood and the power density of radiation at the work site of the workers who were exposed to microwave and high-fequency radiation. The values obtained were compared with the control group. The symptoms and physical signs of disorder in the central nervous and cardiovascular systems of the exposed workers were also studied. The results showed that the average level of 5-HT contained in the whole blood of the group exposed to high-frequency radiation was lower than the level contained in the control group, but the difference was not statistically significant. On the other hand, the average level of 5-HT contained in the group exposed to microwave radiation was significantly lower than in the control group ($P < 0.01$). Each of the two groups of workers, (one of which was exposed to microwave radiation and the other which was exposed to high-freguency radiation) was further divided into two groups: maintainers and operators. The average level of 5-HT in the maintainers of both worker groups was lower than in the control group ($P < 0.01$). The average level of 5-HT in the operators was not significantly different from the control groups ($P > 0.05$). In both radiation groups, the power density of radiation to which the maintainers were exposed was higher than the power density to which the operators were exposed. In addition, the level of 5-HT contained in the whole blood of examinees was in inverse proportion to power density of radiation to which they were exposed. The incidence of neurasthenia syndrome, unsymetric skin temperature in the two limbs, and hypotension was higher in the two exposed groups than in the control group. The incidence of bradycardia in the group exposed to microwave radiation was higher than in the group exposed to high-frequency

radiation. The electrocardiogram of the microwave-radiated group showed higher incidence of premature beat, incomplete-right-bundle-branch block, and changes in S-T segment and T wave than that of the high-frequency-radiated group. This difference in incidence rate of disorders might be related to the different frequency to which the two groups were exposed. Whether it is also related to the level of 5-HT requires further study.

It has already been reported, in China and abroad (1) (2), that non-ionizing radiation, including microwave and high-frequency radiation, can harm the central nervous and cardiovascular systems. 5-HT (5-hydroxytryptamine) is able to regulate the central nervous and cardiovascular systems by supporting their normal activities and by regulating body temperature. In order to understand the relationship between the level of active amine and the radiation field intensity at the work site of the exposed workers, the workers exposed to non-ionizing radiation were physically examined and the level of 5-HT contained in their whole blood was measured. Also, the influence on the functioning of the central nervous and cardiovascular systems was examined in order to diagnose illnesses early.

1. SELECTING OBJECT OF STUDY

121 persons selected for examination were divided in the following three groups: 66 persons in the microwave-radiated group (39 operators, 27 maintainers), 33 persons in the high-frequency-radiated group (17 operators, 16 maintainers), and 22 persons in the control group. Males and females in all three groups were

almost proportionally represented, most of them between 20 and 30 years old. Over 50% of the workers from the two exposed groups had less than 10 years of work experience.

2. STUDY METHOD AND EXAMINATION ITEMS

The radiation-filed intensity was measured at the work site of the two groups of workers exposed to non-ionizing radiation. Blood was drawn from the cubital vein of all of the workers, and 5-HT in the whole blood was measured by fluorometric analysis. In addition, the skin temperature of both limbs was measured, and all of the workers had an electrocardiogram.

3. RESULTS

1. The results of measuring radiation at the work site: Average radiation-power density in the group exposed to microwaves was 70.4 $\mu W/cm^2$. More specifically, the power density at the maintainers' work site was 86.2 $\mu W/cm^2$, and at the operators' work site 54.6 $\mu W/cm^2$. The field intensity at the work site of the group exposed to high-frequency radiation was 80.2 V/m, of which the intensity at the maintainers' site was 81.4 V/m, and the intensity at the operators' work site was 79.0 V/m.

2. As shown in Table 1, the average value of 5-HT in the control group, separately compared to the microwave-radiated group and to the high-frequency-radiated group, showed respective values

of $P < 0.01$, and $P > 0.05$. A separate comparison of the control group with the maintainers exposed to microwave radiation, and the maintainers exposed to high-frequency radiation, showed in both cases $P < 0.01$. A separate comparison of the control group with operators in the two exposed groups showed $P > 0.05$. These results indicate that the average level of 5-HT is related to the power density at the work site.

Table 1. Change in 5-HT Contained in Peripheral Blood of Examinees Exposed to Microwave and High-Frequency Radiation

Group	No. of Examinees	Average Field Power	Measured 5-HT (μmg/ml) Average ± Standard Difference
Micro-wave		μW/cm2	
Operators	39	54.6	75.1 ± 23.6
Maintainers	27	86.2	46.3 ± 17.3
Total	66	70.4	63.6 ± 25.7
High-Frequency		V/m	
Operators	17	79.0	60.7 ± 26.5
Maintainers	16	81.4	47.1 ± 24.7
Total	33	80.2	54.1 ± 26.1
Control	22		84.8 ± 24.2

3. The symptoms in the central nervous system are clearly shown in Table 2. The chief complaints in most cases were fatique, hypomnesia, vertigo, headache, and insomnia. These were followed by somnolence, hypersomnia, excitability, and hyperhidrosis. The incidence of these symptoms was lower in the control group than in the two exposed groups (incidence rate was the highest in the

maintainers group exposed to microwave radiation). Some of the

Table 2. Incidence Rate of Some Symptoms and Physical Signs in Examenees Exposed to Microwave and High-Frequency Radiation

Symptoms and Physical Signs	Positive Rate (%)		
	Microwave (66 Exam.)	High-Frequency (33 Exam.)	Control (22 Exam.)
Fatique	42.4	33.3	9.1
Hypomnesia	34.9	24.1	9.1
Vertigo	33.3	21.1	9.1
Headache	21.2	27.3	13.6
Insomnia	27.3	27.3	4.5
Somnolence	9.1	9.1	0.0
Hypersomnia	25.8	21.2	0.0
Excitability	18.2	15.2	9.1
Hyperhidrosis	27.3	21.2	9.1
Neurasthenia Syndrome	27.3	21.2	9.1
Nervousness	13.6	15.2	4.5
Unsymmetric Skin Temp. in Both Limbs	16.7	9.1	4.5
Hypotension *	13.6	12.1	4.5
Sinus Bradycardia	21.2	12.1	9.1
Sinus Tachycardia	12.1	21.2	13.6
Premature Beat	12.1	6.1	9.1
T Wave: Low, Inverted, and Bidirectional	12.1	9.1	0.0
Decli[illegible] of S-T [illegible]ment **	10.6	9.1	4.5
Incom[illegible]ete Right-Bundle-Branch Block	13.6	6.1	9.1

* Contraction pressure lower than 12.0 kPa (90 mm Hg) or diastolic pressure lower than 8.0 kPa (60 mm Hg).
** Decline of S-T segment: drop $\geq$ 0.05 mV in at least two leads of the S-T segment.

examined workers showed a number of the above mentioned symptoms. The examinees who simultaneously showed five or more symptoms (neurasthenia syndrome) accounted for 27.3% of the microwave-

radiated group, 21.2% of the high-frequency-radiated group, and 9.1% of the control group. A separate comparison of the control group with the two exposed groups showed an average of $P < 0.01$. A separate comparison of the control group to the maintainers and the operators in each of the two radiation groups showed an average of $P < 0.05$. The examined workers showing unsymmetric skin temperature in the two limbs accounted for 16.7% of the microwave-radiated group, 9.1% of the high-frequency-radiated group, and 4.6% of the control group. Therefore, the difference between the control group and the microwave-radiated group was remarkable. The number of examinees whose chief complaint was nervousness was evidently higher in the two exposed groups than in the control group. Nine examineees in the microwave-radiated group showed hypotension, which accounted for 13.6% of the group (among them six persons were maintainers which accounted for 22.2% of the respective group, and three persons were operators, which accounted for 7.69% of the respective group). Four examinees from the high-frequency-radiated group showed hypotension, which accounted for 12.1% of the group. One examineee showing hypotension in the control group accounted for 4.5% of the group. A separate comparison of the control group with the microwave-radiation group showed an average of $P < 0.05$. A separate comparison of the two radiated groups with the control group showed the average value of $P < 0.05$. 14 examineees in the microwave-radiated group showed bradycardia, which accounted for 21.2% of the group. Four examinees in the high-frequency radiated group showed bradycardia, which accounted for 12.1% of the group.

Two examinees in the control group showing bradycardia accounted for 9.1% of the group. A Separate comparison of the microwave-radiated group with the control group showed an average of $P < 0.05$. The comparison of high-frequency-radiated group with the control group showed an average of $P > 0.05$. The electrocardiogram of the maintainers exposed to microwave radiation showed a remarkably higher incidence ratio of decline in S-T segment, low T wave, inverted T wave, and bidirectional T wave, premature beat, and incomplete-right-bundle-branch block than in the maintainers exposed to high-frequency-radiation, or in the examinees from the control group.

4. DISCUSSION

The microwaves and the high-frequency waves both belong within the scope of radio waves, and their characteristics are similar. Although each has a different frequency, both are within the limits of what is called non-ionizing radiation. At present, their mechanism, and especially the mechanism of microwave radiation, is still not clear. Two theoretical interpretations: theory of devoted thermal effect and theory of undevoted thermal effect (superconductivity, photochemical effect, elastic expansion, polarization expansion, electromagnetic-resonance effect, field-power effect, etc.) were used in an attempt to find the principle of their functioning.

5-HT is widely distributed inside organisms, and possesses

strong physiological activity. The tryptophan enzyme produces the main effect of 5-HT in the human body, which is executed by hydroxylase and decarboxylation. 5-hydroxy-indole acetic acid (5-HIAA), a metabolite and the end product of 5-HT, is discharged through urine (3).

We are confident that certain neurons in the central nervous system have the ability of responding to 5-HT effect. Experiments with rats confirmed that 5-HT regulates the central nervous system, and enables normal thinking activity. A decrease in 5-HT in the body of animals causes somnipathy, and lowers the pain treshold (5-HT passes through the main nerves related to sense of pain), which consequently affects the condition of animal's nervous system (4, 5). In humans of normal physiological condition, the 5-HT is not able to pass blood-cerebral barriers. In humans exposed to non-ionizing radiation, however, it is not necessarily the case. Albert's experiment and other tests on animals showed that low-power microwave radiation can cause osmotic increase of blood-cerebral barrier in voles (6). Therefore, in regard to an organism exposed to microwave radiation, there is a possibility that osmosis will occur between the 5-HT in the body (or in the blood) and the 5-HT inside the brain. The incidence rate of neurasthenia syndrome in the two exposed groups studied in this article (particularly in the microwave-radiated group), as well as in the maintainers of the both exposed groups, were evidently higher than in the control group. This was caused by the level of 5-HT contained in the organism, by direct damage of the central-nervous-system functions

after the exposure to non-ionizing radiation, or by the additive effect of both. In regard to this, a further study is necessary.

5-HT produces cardiovascular effect (7~9). 5-HT functions as a physiological element which regulates the cardiovascular system. The number of examinees with hypotension in the two exposed groups studied in this research was remarkably different from the control group. Among the workers exposed to microwave radiation, the maintainers showed a lower average level of 5-HT than the operators. The power density at the work site and the incidence rate of hypotension, however, were higher in the maintainers. This might be interpereted as a decrease in 5-HT caused by microwave radiation. Afterwards, the decrease induces hypotension. The mechanism of this process, however, requires further study.

The reports of the change in functioning of the heart of test animals caused by 5-HT are not consistent. Some sources indicate that 5-HT induces tachycardia (8, 10), while others claim that it causes bradycardia, irregular change, or no change at all (7, 8, 10). This study showed that the number of cases of bradycardia in examineees exposed to microwave radiation was evidently higher than in examinees exposed to high-frequency radiation. The electrocardiograms also showed higher incidence of other abnormal items in the examinees exposed to microwave radiation than in examinees exposed to high-frequency radiation. The average level of 5-HT in the group exposed to microwave radiation, however, was higher than in the group exposed to high-frequency radiation. The average level of 5-HT in maintainers of

both exposed groups was close. Therefore, the decrease in the level of 5-HT can hardly be used as a viable explanation. The possibility that the difference in frequency caused different effects in the two exposed groups (the frequency in microwave-radiated group was higher than the frequency in high-frequency-radiated group) is worth considering.

The findings of this study indicate that the safe health standards for microwave radiation should be formulated so that the radiation power density at the work site does not exceed 54 $\mu W / cm^2$ and that the field power of high-frequency radiation at the work site does not exceed 79 V / m. In addition, the measuring of 5-HT contained in the whole blood could be used in the future as a referential index in physical examinations and diagnosing.

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